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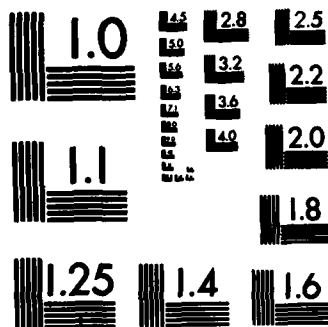
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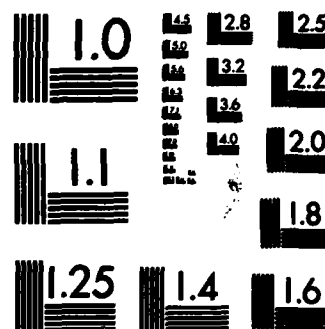
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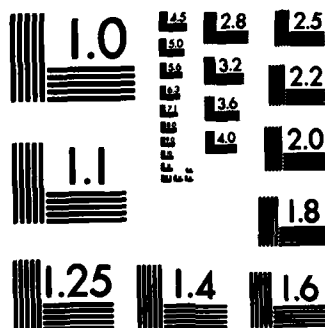




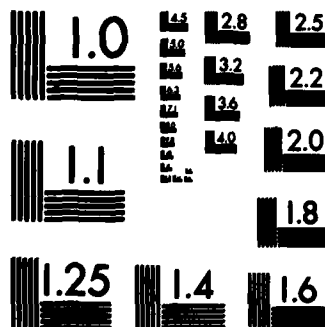
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USAARL REPORT NO. 82-10

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CATHODE-RAY-TUBE RASTER LINE SELECTOR WITH HORIZONTAL MODULATION CAPABILITY

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and
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RESEARCH SYSTEMS DIVISION
SENSORY RESEARCH DIVISION

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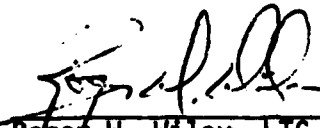
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INTRODUCTION

With the increased usage of cathode-ray-tube (CRT) displays in the areas of target detection and recognition, a greater emphasis has been placed on the ability to measure the image quality of these displays. Much of this effort has been restricted to determining the image quality for static targets. Only recently has attention been focused on dynamic imagery, that is, imagery resulting from relative target/sensor motion.

The US Army Aeromedical Research Laboratory (USAARL) has been investigating the parameters of CRT displays which affect the imaging of targets in motion and techniques that can quantify the image degradation resulting from this motion. In the attempt to develop methods and instrumentation to aid in this investigation, it was decided to enhance the normally available control of the individual raster lines of the CRT display.

To reach this goal, a circuit was developed which provides a simple method of selecting the number and position of active raster lines on the CRT display. The circuit development was actually accomplished in two stages. First, a circuit was developed which allowed the selection of the number of active raster lines and their position. In the second stage, the capability to modulate these lines horizontally was added.

CIRCUIT DESCRIPTION FOR RASTER LINE SELECTOR

The circuit shown in Figure 1* allows the user to select from zero to five active lines and control the vertical position at which they occur on the display. The required inputs are a negative-going vertical blanking signal and horizontal and vertical synchronization pulses.

The active lines are written at the frame rate. In other words, the standard interlacing method of presenting two alternating active fields is defeated. This is accomplished by blanking the electron beam on alternating fields. The number of active lines is controlled by the width of a pulse which turns on the electron beam. The time at which the beam is turned on, referenced to the active field's vertical sync pulse, determines the positioning of the active lines.

* Component values are given in Appendix .

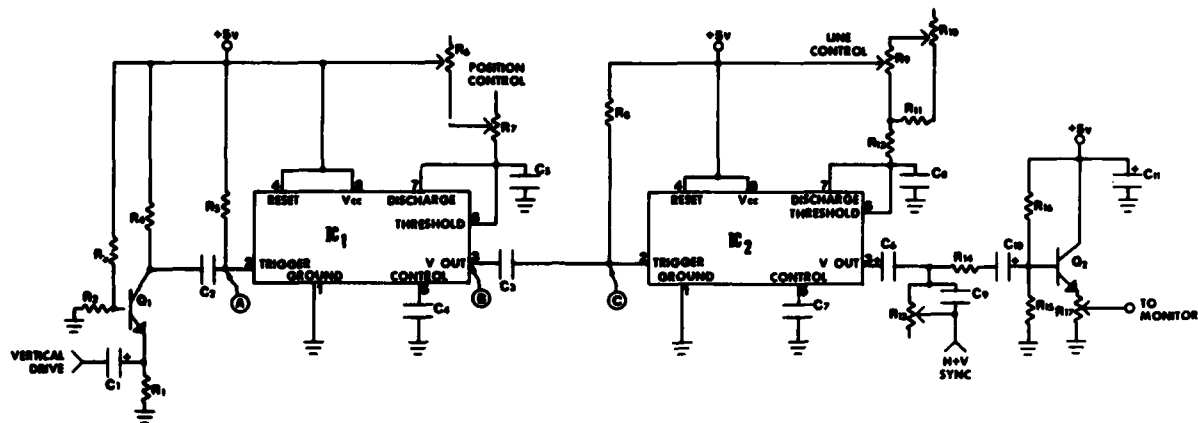


Figure 1. Schematic for raster line selector circuit.

The vertical drive pulses are applied through coupling capacitor C_1 to the emitter of transistor Q_1 which is operating as a common-base amplifier. The amplification insures that the pulses will be of sufficient driving amplitude when they arrive at pin 2 of IC_1 . The amplified vertical drive pulses are taken off of the collector of Q_1 and differentiated by coupling capacitor C_2 and resistor R_5 before being fed into the TRIGGER pin (pin 2) of IC_1 . IC_1 is a 555 timer configured as a monostable multivibrator (one shot). The pulse width of the output pulses available on pin 3 is controlled by capacitor C_5 and the control potentiometer R_6 in combination with R_7 . This potentiometer positions the active raster lines on the display. Actual waveforms present at test points A and B, noted on the schematic, are shown in Figure 2. The differentiated pulses at test point A have a period of 17 msec. The pulses at pin 3 of IC_1 (test point B) can vary in width between 17 and 33 msec. This pulse makes its high to low transition during alternate fields. Where this transition occurs within the field determines the location of the active lines within the field.

The output from pin 3 on IC_1 is differentiated by the RC combination of coupling capacitor C_3 and resistor R_8 . The resulting pulses are fed to the TRIGGER input (pin 2) of IC_2 , which is also a 555 timer used in a monostable multivibrator configuration. The timing period of IC_2 is controlled by capacitor C_8 and the control potentiometer R_9 . Adjusting R_9 , which varies the pulse width of the output of IC_2 , selects the number of lines which will be active on the display. For the values indicated, up to five consecutive lines may be selected, requiring a pulse width of from 0 to 315 μ sec. Waveform C (from test point C) is shown in Figure 2.

The output from pin 3 of IC_2 is then combined with the horizontal and vertical sync pulses and applied to the base of transistor Q_2 which acts as an emitter follower. The final output, taken off of potentiometer R_{17} , can be fed directly into a 75 ohm input on the display.

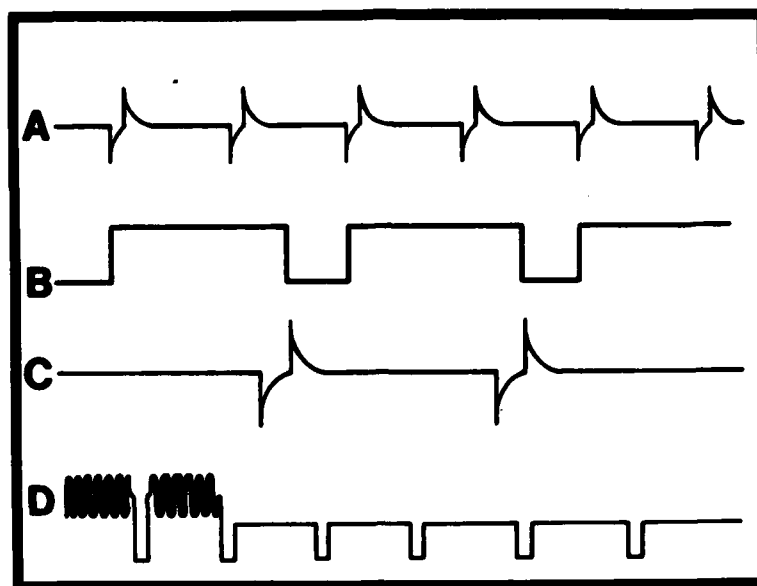


Figure 2. Actual waveforms for test points A - D.

CIRCUIT DESCRIPTION FOR RASTER LINE SELECTOR WITH HORIZONTAL MODULATION CAPABILITY

In order to provide for the capability of modulating the active horizontal raster lines, the previously developed circuit was slightly modified. The new schematic is shown in Figure 3.* The input of the horizontal and vertical sync pulses was moved to the base circuit of the third stage (Q_5) of an added three-stage amplifier. The desired modulating signal is input to the emitter of the first stage (Q_3). The first and second stages are a common-emitter configuration; the third stage is configured as an emitter-follower.

The modulation occurs in the transistor Q_3 . The pulse which arrives at the base of Q_3 has a pulse width equal to $\sim 53 \mu\text{sec}$, or a multiple thereof, the time required for one (or more) horizontal line scan. Transistor Q_3 will have a change in its collector (output) voltage only when the base voltage, i.e., the pulse amplitude, exceeds 0.6v. The signal applied to the emitter of Q_3 will have an effect on the collector (output) voltage only when Q_3 has been turned on. The resulting signal will be modulated pulses of width equal to the horizontal line scan period. The waveform representing this signal (at test point D in Figure 3) is shown in Figure 2.

* Component values are given in Appendix A.

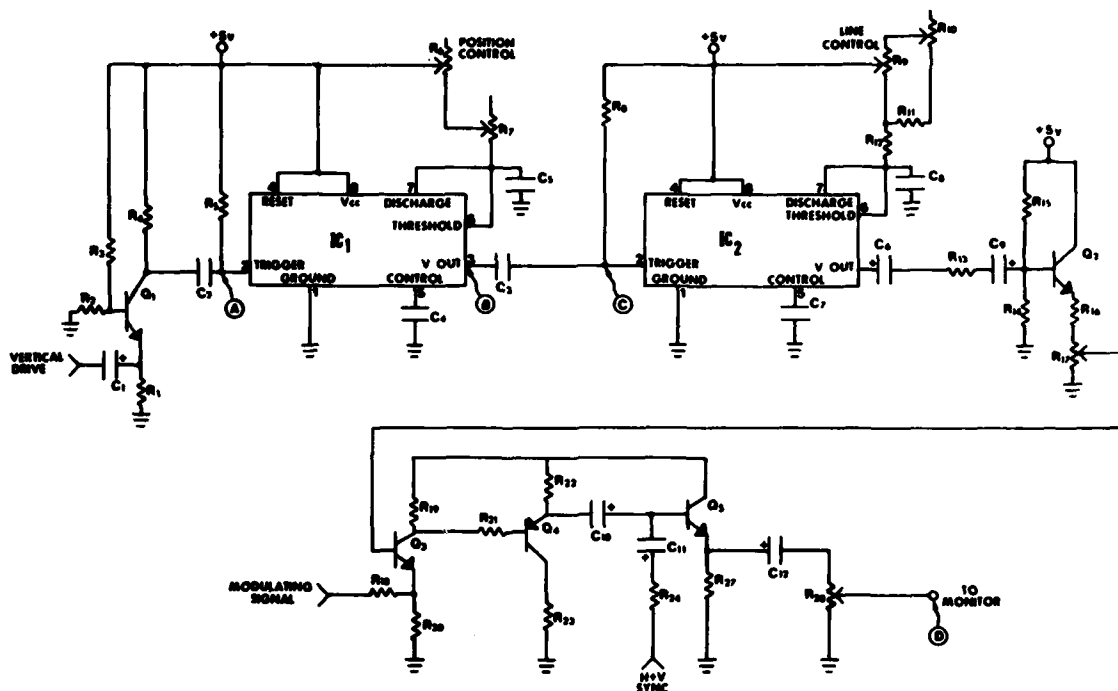
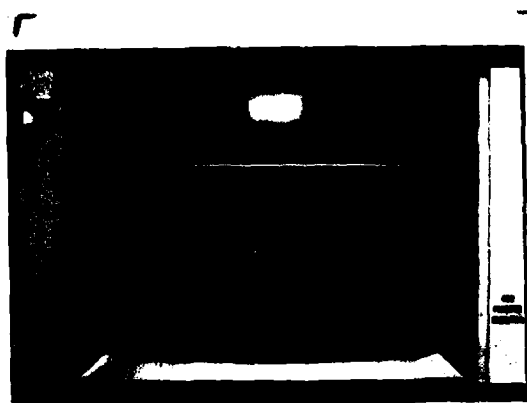


Figure 3. Schematic for raster line selector circuit with horizontal modulation capability.

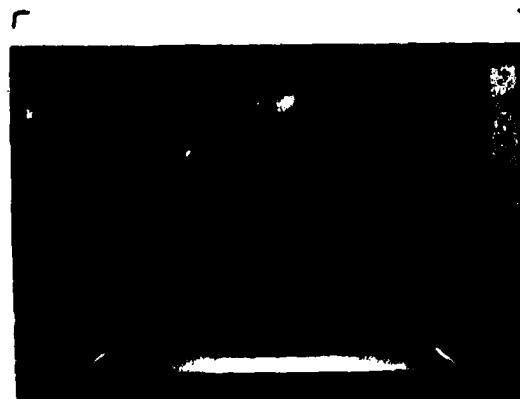
DISCUSSION

The capabilities of the final circuit (in Figure 3) are demonstrated in the actual display photographs presented in Figure 4. As shown, the number of active lines can be varied, and the location of the active lines can be anywhere on the raster. The number of active lines available for the circuit described is from zero to five. If more lines are required, suitable substitutions for capacitor C₈ and the resistor network R₉-R₁₂ (Figure 3) can be made.

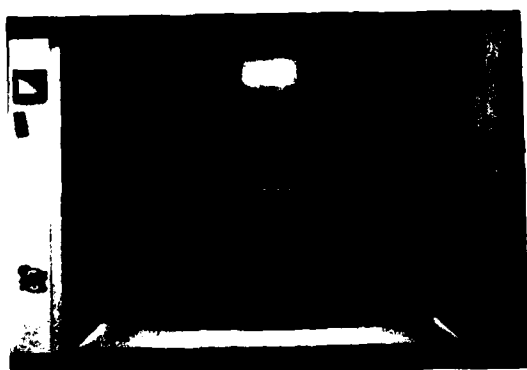
The ability to reduce the number of raster lines to one and position this line anywhere on the display will simplify the analysis of pixel response by removing the additional PMT response from preceding and succeeding lines. Single line modulation transfer function analysis may also be enhanced by the ability of this circuit to produce a single modulated line.



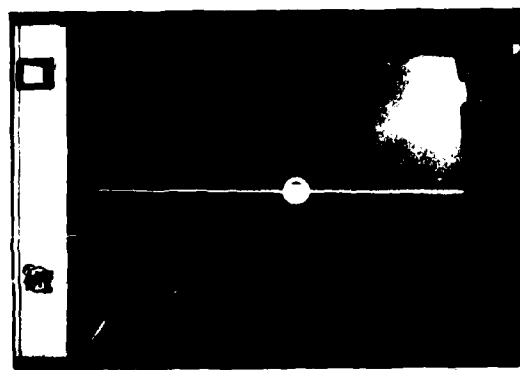
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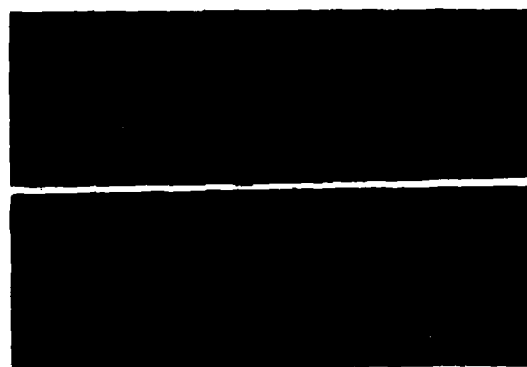
(b)



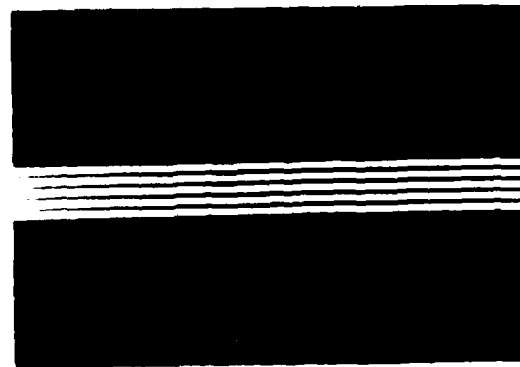
(c)



(d)



(e)



(f)

FIGURE 4. Photographs of actual rasters demonstrating circuit capabilities.
 (a and b) Location of active lines can be seen anywhere on display.
 (c and d) The number of raster lines can vary.
 (e and f) Close-up view of actual raster with single and multiple active lines.

APPENDIX
LIST OF COMPONENTS

FOR FIGURE 1

INTEGRATED CIRCUITS

IC₁, IC₂ - 555 Timer

RESISTORS*

R₁ - 270 Ω
R₂ - 2.2K Ω
R₃, R₅, R₈ - 22K Ω
R₄, R₁₄ - 1K Ω
R₆ - 400K Ω
R₇ - 2M Ω
R₉, R₁₀ - 100K Ω
R₁₁ - 62K Ω
R₁₂ - 21K Ω
R₁₃ - 5K Ω
R₁₅ - 6.8K Ω
R₁₆ - 20K Ω
R₁₇ - 500 Ω

TRANSISTORS

Q₁, Q₂ - 2N3904

CAPACITORS

C₁, C₆, C₁₁ - 100 μ f, 10 VDC, electrolytic
C₂, C₃, C₉ - .001 μ f
C₄, C₇ - .01 μ f
C₅ - .039 μ f
C₈ - .0019 μ f
C₁₀ - 200 μ f, 16 VDC, electrolytic

FOR FIGURE 2

INTEGRATED CIRCUITS

IC₁, IC₂ - 555 Timer

RESISTORS*

R₁, R₂₀ - 270 Ω
R₂ - 2.2K Ω
R₃, R₅, R₈ - 22K Ω
R₄, R₁₃, R₂₁, R₂₄ - 1K Ω
R₆ - 400K Ω
R₇ - 2M Ω
R₉, R₁₀ - 100K Ω
R₁₁ - 62K Ω
R₁₂ - 21K Ω
R₁₄ - 6.8K Ω
R₁₅ - 20K Ω
R₁₆ - 2K Ω
R₁₇, R₂₈ - 500 Ω
R₁₈ - 300 Ω
R₁₉ - 4.7K Ω
R₂₂ - 150 Ω
R₂₃ - 3.3K Ω
R₂₅ - 10K Ω
R₂₆ - 47K Ω
R₂₇ - 470 Ω

TRANSISTORS

Q₁, Q₂, Q₃, Q₅ - 2N3904
Q₄ - 2N3906

CAPACITORS

C₁, C₆ - 100 μ f, 10 VDC, electrolytic
C₂, C₃ - .001 μ f
C₄, C₇ - .01 μ f
C₅ - .039 μ f
C₈ - .0019 μ f
C₉ - 200 μ f, 16 VDC, electrolytic
C₁₀, C₁₁ - 10 μ f, 50 VDC, electrolytic
C₁₂ - 47 μ f, 16 VDC, electrolytic

*All fixed resistors are 10%, 1/4-watt.

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